Geologic Resource Evaluation Scoping Summary
Casa Grande Ruins National Monument, Arizona

Geologic Resources Division
National Park Service
U.S. Department of the Interior

The goal of the Geologic Resource Evaluation (GRE) Program is to provide each "natural area" park with a digital geologic map and a geologic resource evaluation report. As a means of obtaining this goal, the NPS Geologic Resources Division (GRD) coordinates scoping meetings that bring together park staff and local geologic experts. The scoping process includes an evaluation of the adequacy of existing geologic maps and a discussion of park-specific geologic management issues. When possible, a site visit with local experts is also part of the scoping process. Outcomes are a scoping summary (this report), a digital geologic map, and a geologic resource evaluation report. Along with the completed digital map, this scoping summary will serve as the starting point for the final GRE report for Casa Grande Ruins National Monument.

The National Park Service held a GRE scoping meeting in Coolidge, Arizona, for Casa Grande Ruins National Monument on Monday, May 8, 2006. Discussion during the meeting addressed geologic mapping coverage and needs, geologic processes and features, resource management issues related to these features and processes, and potential monitoring and research needs. Participants at the meeting included NPS staff from the monument, Geologic Resources Division, and Sonoran Desert Network, as well as cooperators from the Arizona Geological Survey and Colorado State University (table 1). Melanie Ransmeier (NPS Geologic Resources Division) facilitated the discussion of map coverage, and Lisa Norby (NPS Geologic Resources Division) led the discussion regarding geologic processes and features at the monument. After the formal meeting, Rebecca Carr led a tour of the national monument for GRE staff members.

Table 1. Scoping Session Participants

Name	Affiliation	Phone	E-Mail
Lee Allison	Arizona Geological Survey (state geologist)	520-770-3500	lee.allison@azgs.az.gov
Debbie Angell	NPS Sonoran Desert Network (GIS specialist)	520-731-3420 x. 1	debbie_angell@nps.gov
Rebecca Carr	Casa Grande Ruins National Monument (archaeologist)	520-723-3172	rebecca_carr@nps.gov
Katie KellerLynn	Colorado State University (geologist/research associate)	801-364-1716	katiekellerlynn@msn.com
Lisa Norby	NPS Geologic Resources Division (geologist)	303-969-2318	lisa_norby@nps.gov
Phil Pearthree	Arizona Geological Survey (geologist)	520-770-3500	phil.pearthree@azgs.az.gov
Melanie Ransmeier	NPS Geologic Resources Division (GIS specialist)	303-969-2315	melanie_ransmeier@nps.gov
Carol West	Casa Grande Ruins National Monument (superintendent)	520-723-3172	carol_west@nps.gov

Status of Scoping and Products
As of May 2006, the NPS Geologic Resources Division had completed the scoping process for 169 of 270 "natural resource" parks. Staff and partners of the GRE Program have completed digital maps for 69 parks. These compiled geologic maps are available for download from the NR-GIS Metadata and Data Store at http://science.nature.nps.gov/nrdata. The U.S. Geological Survey, various state geological surveys, and investigators at academic institutions are in the process of preparing mapping products for 49 additional parks. Writers have completed 22 GRE reports with 60 additional reports in progress.

Park and Geologic Setting
The Casa Grande Ruin Reservation was authorized on March 2, 1889, and proclaimed on June 22, 1892. It was re-designated a national monument on August 3, 1918. Boundary changes occurred in 1909 and 1926. The unit was established to preserve a multistoried, earthen-walled, 13th-century Hohokam structure and associated artifacts.

For more than a thousand years, prehistoric farmers inhabited much of the present-day state of Arizona. When the first Europeans arrived, all that remained of this ancient culture were the ruins of villages, irrigation canals, and various artifacts of the Hohokam Indians. Among these ruins is the Casa Grande or Big House—one of the largest and most mysterious prehistoric structures ever built in North America. Casa Grande Ruins National Monument, the nation’s first archaeological preserve, protects the Casa Grande and other cultural sites within its boundaries.

Casa Grande Ruins National Monument sits near the transition zone of the Colorado Plateau—a relatively high, undeformed area—and the Basin and Range province, which is characterized by tilted fault blocks that form long, asymmetrical ranges or mountains and broad, intervening basins. Approximately 50 million years ago the region would have resembled the present-day Andes Mountains in South America. Central Arizona was a convergent zone with associated volcanism. Between 10 and 30 million years ago, the normal-faulted, subsiding, basin-and-range terrain formed. Internal drainage resulted in the formation of evaporite deposits in some basins.

Development of the modern Gila River system began sometime after 9 million years ago; an early version of the Gila River clearly existed in this area by 3 million years ago. Between 10,000 and 100,000 years ago, the Pleistocene-age Gila River deposited a river terrace upon which the Hohokam built Casa Grande (see Waters, 2000). The terrace contains calcium carbonate and clay, which increases durability of the structures built from these materials. The Casa Grande site is situated 20–30 feet above the Gila River, which would have made getting water more difficult for the Hohokam; however, the location would have protected the inhabitants from flooding.

The Gila River has flooded numerous times in the historical period (Huckleberry, 1994). Floods occur primarily during the winter or fall; peaks are now lower but of longer duration because of dams on the river. The largest historical flood on record occurred in 1905. More recently, large floods have occurred in 1983 and 1993; neither of these directly affected Casa Grande Ruins National Monument. In the past, large floods would have affected the channel width and the canals that the Hohokam built. As recently as 90 years ago, flood flow from the Santa Cruz River passed just west of the monument. Greens Canal, which was constructed in the early 1900s, now diverts flood flows on the Santa Cruz River west of the Casa Grande Mountains and the town of Casa Grande.

Earth fissures, which form as a result of groundwater withdrawals in the area, are a recent geologic phenomenon. Increasing since the 1930s, over-pumping of groundwater for agricultural use and encroaching human developments in the vicinity of Casa Grande National Monument causes these fissures and associated subsidence (see “Earth Fissures” section). Once formed, the fissures can concentrate water flows during rain events and enlarge the fissures.

Geologic Maps for Casa Grande National Monument

During the scoping session on May 8, 2006, Melanie Ransmeier (GRD) showed some of the main features of the NPS GRE Geology-GIS Geodatabase Data Model—the digital geologic map model used by the GRE Program. The model reproduces all aspects of a paper map, including notes, legend, and cross sections, with the added benefit of being GIS compatible. Staff members digitize maps or convert digital data using ESRI ArcMap software. Digital data are provided in each of the following three formats: geodatabase, shapefile, and coverage. Layer files (legends), FGDC-compliant metadata, and a Windows HelpFile that captures ancillary map data, are also part of the final dataset.

Parks in Inventory and Monitoring Networks have identified 7.5-minute “quadrangles of interest.” In general, digital geologic data from 7.5-minute quadrangles (scale 1:24,000) suit the purpose of geologic resource evaluations. The geologic features mapped at this scale are equivalent to the width of a one-lane road. Quadrangles of interest are used as a starting point for discussion in determining the components of the final digital geologic map for a park. A recent policy change for the GRE Program, however, excludes from potential digitizing any quadrangles that do not include a portion of the park. This policy change occurred at the time of scoping at Casa Grande Ruins National Monument. Hence, this summary attempts to outline an action plan that incorporates this new policy while providing a digital map useful for resource management.

Map coverage for Casa Grande Ruins National Monument originally consisted of four quadrangles of interest (scale 1:24,000): Blackwater, Florence, Coolidge, and Valley Farms. The Blackwater and Florence quadrangles are situated on the Mesa 30' × 60' sheet; the Coolidge and Valley Farms quadrangles are situated on the Casa Grande 30' × 60' sheet (see fig. 1 and table 2). Park staff would also be interested in existing data for the Gila Butte Northwest quadrangle. The Gila River Indian Community Area and Hohokam Pima National Monument, which is jointly managed with Casa Grande National Monument, are within this quadrangle, and the data could benefit the National Park Service–Hohokam Pima relationship in the future.

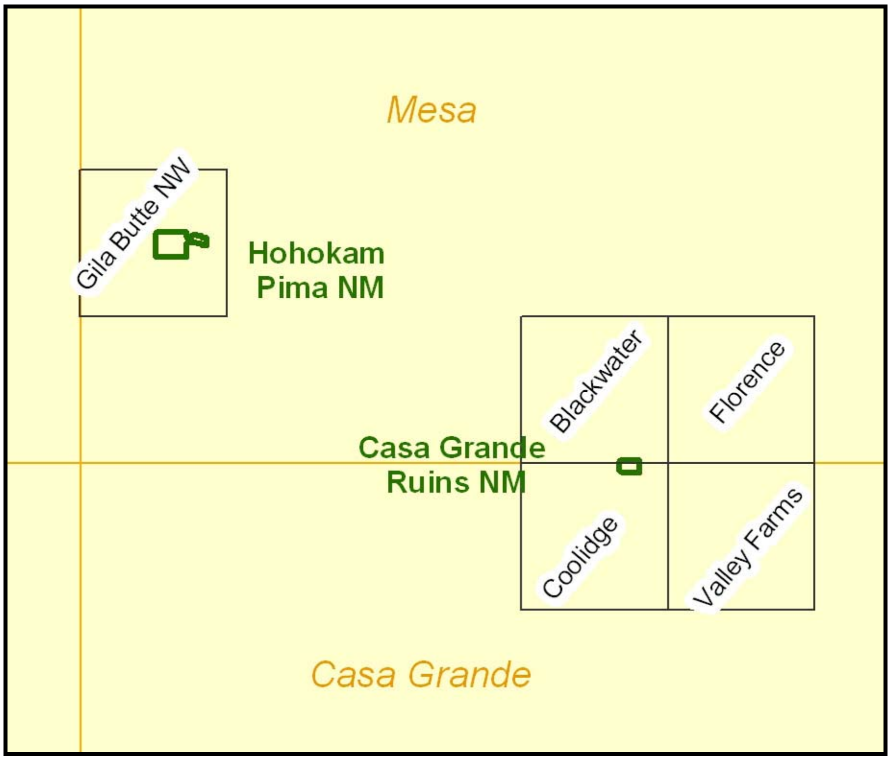

Figure 1. Quadrangles of interest for Casa Grande Ruins National Monument and Hohokam Pima National Monument, Arizona. The 7.5-minute quadrangles are labeled in black; names in yellow indicate 30-minute by 60-minute quadrangles. Green outlines indicate monument boundaries.

Table 2 outlines the GRE plan for providing digital geologic data for Casa Grande Ruins National Monument. In short, GRE staff will provide digital data for the Blackwater and Coolidge quadrangles as these both include portions of Casa Grande National Monument. The published (paper) geologic map for the Florence quadrangle (scale 1:24,000) and the digital data for the Gila Butte Northwest quadrangle (scale 1:100,000) are available from the Arizona Geological Survey. GRE staff will help coordinate transfer of this information to park staff.

During the scoping meeting, Phil Pearthree (surficial geologist at the Arizona Geological Survey) mentioned that he had mapped the Valley Farms quadrangle as part of the geologic mapping for the Casa Grande 30' × 60' project (scale 1:100,000). However, during field work he mapped at scale 1:24,000, though not in great detail. Though GRE staff will not convert these data as proposed during the scoping meeting, the data may be available for park use. GRE staff should follow up with the Arizona Geological Survey to determine the status of this unpublished project and assist with transfer of data to staff at Casa Grande Ruins National Monument (Contact: Phil Pearthree, 520-770-3500, phil.pearthree@azgs.az.gov).

Table 2. Geologic Mapping Plan for Casa Grande Ruins National Monument

Quadrangle	GMAP[1]	Citation	Scale	Format	Assessment	GRE Action
Blackwater	74379	Huckleberry, G., 1992, Surficial geology of the eastern Gila River Indian Community Area, western Pinal County—Blackwater 7.5' quadrangle [sheet 6 of 6]: Arizona Geological Survey Open-File Report OFR 92-07, scale 1:24,000.	1:24,000	paper	This multi-plate map provides 1:24,000-scale surficial geologic coverage.	Digitize the paper map for sheet 6 of this publication.
Coolidge	74372	Klawon, J.E., Pearthree, P.A., Skotnicki, S.J., and Ferguson, C.A, 1998, Geology and geologic hazards of the Casa Grande area, Pinal County, Arizona—Geologic map of the Coolidge 7.5' quadrangle [sheet 4 of 6]: Arizona Geological Survey Open-File Report OFR 98-23, scale 1:24,000.	1:24,000	paper and digital	This multi-plate map provides 1:24,000-scale geologic hazard data and surficial-geology coverage.	Acquire digital data for sheet 4 of this publication and convert to NPS GRE digital geologic data model.
Florence	1447	Huckleberry, G., 1993, Surficial geology of the middle Gila River area, north-central Pinal County, Arizona—Florence 7.5' quadrangle [sheet 1 of 5]: Arizona Geological Survey Open-File Report OFR 93-03, scale 1:24000.	1:24,000	paper	This multi-plate map provides 1:24,000-scale surficial geology.	Follow up with Arizona Geological Survey to provide map to park staff.
Valley Farms		Unpublished—reconnaissance mapping by the Arizona Geological Survey	1:100,000	digital	This map is part of the Casa Grande 30' × 60' sheet but was mapped at scale 1:24,000.	Follow up with Arizona Geological Survey to potentially transfer data to park staff.
Gila River Northwest	35899	Huckleberry, G., 1992, Surficial geology of the eastern Gila River Indian Community Area, western Pinal County—Gila Butte 7.5' quadrangle [sheet 1 of 6]: Arizona Geological Survey Open-File Report OFR 92-07, scale 1:24,000.	1:24,000	paper	This multi-plate map provides 1:24,000-scale surficial geologic coverage.	Follow up with Arizona Geological Survey to transfer data to park staff.

[1]GMAP numbers are identification codes used in the GRE database.

Geologic Features, Processes, and Issues at Casa Grande Ruins National Monument

The scoping session for Casa Grande Ruins National Monument provided the opportunity to develop a list of geologic features and processes in the monument, which will be further explained in the final GRE report. Of particular significance for resource management in the national monument is geologic research related to archaeology. During the meeting, park staff prioritized the issues as follows:

1. Fluvial Features and Processes (including the effect of water erosion on archaeological resources)
2. Wind erosion (of archaeological resources)
3. Earth fissures (caused by groundwater withdrawal)
4. Seismic features and processes (effect on prehistoric structures)

Fluvial Features and Processes and Water Erosion

Casa Grande Ruins National Monument is situated on a Pleistocene-age terrace of the Gila River. Modern-day flood hazards consist of lateral erosion of the channel (up to 500 feet in Holocene floodplain alluvium during individual floods), local flash floods that produce standing water in the monument, and overflow of wash banks. Meeting participants discussed the possibility of using predictive models for determining the potential areas for lateral (bank) erosion at the monument.

Other types of erosion include gullying of valley fill deposits, which exposes cultural resources. Gutters move water from the Casa Grande shelter—designed by Frederick Olmsted and built in 1932—to the west of the ruin; otherwise, no culverts drain the monument area. Hence, some archaeological features (and potentially infrastructure) are affected by sheetwash. Additionally, [rainsplash] causes erosion of exposed prehistoric structures (e.g., the Big House, archaeological mounds, and Compounds A and B) at the monument.

Useful research for park management includes an examination of the geological "zones" most suitable for planting vegetation that could stabilize fill without degrading the integrity of the Hohokam structures. Determining the relationship between changes in vegetative cover due to groundwater drawdown would also be beneficial.

Eolian (Windblown) Features and Processes

A thin veneer of eolian deposits (silt) occurs on the river terraces at Casa Grande National Monument. Deposition of windblown sediment also occurs inside the ruins. Eolian deposits cover and expose many archaeological remains, causing abrasion of cultural features. In addition, "micro-hoodoos" have formed around caliche and pebbles in the adobe structures (e.g., the Big House).

Park staff would like to monitor eolian processes and the erosion of archaeological features in the monument. Investigators from the University of Pennsylvania (Department of Historic Preservation Architectural Conservation Laboratory) conducted a baseline condition assessment for the Big House in Compound A in 1997–1998. However, it should be noted that the Big House is only one structure within Compound A; there are a total of 62 archeological sites within Casa Grande Ruins National Monument. In 2005–2006 Ronald Beckwith and Rebecca Carr are conducting baseline condition assessments for all of the other structures. This assessment is scheduled for completion by October 2006 (R. Carr, Casa Grande Ruins National Monument, written communication, June 26, 2006).

Earth Fissures

Phil Pearthree from the Arizona Geological Survey described the formation of earth fissures during his geologic presentation of the national monument. Earth fissures have caused subsidence of areas 10 feet in width and 50 feet in depth in the general vicinity of the monument. Over-pumping of groundwater causes land subsidence, and earth fissures have formed around the margins of subsiding basins. Significant groundwater withdrawals, in particular for agricultural use, have occurred in the vicinity of Casa Grande since the 1930s. This has resulted in a drop in the water table from 20 feet to 400 feet below ground level and the development of a number of earth fissures. During the 1980s, the Central Arizona Project brought surface water from the Colorado River into the area, which slowed or stopped the decline of groundwater levels in this area. However, recent human development and the drought have increased demands on groundwater and may exacerbate fissure formation once again.

Coolidge, Arizona, the closest city to the monument lies in the middle of the Gila River basin. Because the basin is filled with unconsolidated sedimentary deposits (alluvium), fewer fissures have formed here than along the margins of the alluvial valley. For example, in Queen Creek, Arizona, which is on the margin of the basin, a park employee's front yard "opened up" with an earth fissure. Where basin fill and bedrock converge along the basin margins, earth fissures form and capture drainage, thereby accelerating erosion and expanding the size of the fissure. Fissures potentially reach several hundred feet deep and provide conduits to groundwater.

In addition, development has increased water use and fissure development; for instance, 40,000 homes have been built in Queen Creek, which is a portrait for what Coolidge could become in the near future.

Immediately west of the monument's boundary, 126 acres are in the planning stages of a large residential development. This is a concern for resource management because groundwater withdrawal and the potential for earth fissure development could affect the integrity of archaeological structures and other sites in the national monument.

Seismic Features and Processes
The epicenter of the largest historical earthquake (estimated 7.3–7.5 magnitude) in the vicinity of Casa Grande Ruins National Monument was in Sonora, Mexico, in 1887; this quake was felt in Phoenix and Tucson and would have been felt at the monument. However, at the time, only a stage coach route (no town) was established here.

Seismic risk for the area is low; geologists have not identified any major faults in a 50-mile radius of the area. However, human-caused vibrations (e.g., from airplanes, trains, blasting, and construction) may affect the integrity of the archaeological structures.

Disturbed Lands
In some cases "disturbed lands" at Casa Grande Ruins National Monument may be cultural resources, that is, the result of the Hohokam mining for building materials. Although present-day mining (i.e., sand and gravel) occurs in the vicinity of the monument, none occurs within its boundaries. When the monument was first established illegal grazing was a big problem; this led to fencing around the boundary of the monument.

Unique Geologic Features at Casa Grande Ruins National Monument
Unique geologic features may include geologic features mentioned in a park's enabling legislation, features of widespread geologic importance, geologic resources of interest to visitors, or geologic features worthy of interpretation. Type localities and age dates are also considered unique geologic features. At Casa Grande Ruins "unique features" include salt deposits and geochemical data.

Salt Deposits
Salt in many forms is tied to the ruins. First, original sources of building material contained evaporite (salt) deposits. Second, overpumping of groundwater for domestic and agricultural use in the area is depleting the water table and increasing the salinity of groundwater. Potentially, salt-saturated groundwater is wicked into the prehistoric Hohokam structures, accelerating their erosion. Third, sulfates occur as an atmospheric source of salts. Acid rain (sulfates) or other atmospheric sources could contribute to erosion of archaeological structures. Fourth, salt efflorescence causes accelerated erosion on the structures, especially between the mortar and walls. Park staff has a baseline measure of salt efflorescence in the Big House. Park employees would like to determine whether salt efflorescence has increased in modern times or is a property of the original building materials.

Geochemical Data
Useful geochemical data include identifying trace elements used for finding source areas of Hohokam building materials. For instance, ceremonial paint may have been traded with other Native Americans from distant areas. Also, as the building materials are high in calcium carbonate, determining the extent of calcium-carbonate deposits used for construction would enhance understanding about the ruins. Finally, dating the Gila terraces would shed light on the recent geologic history of the area before and during human occupation.

References
Waters, M.R., 2000, Alluvial stratigraphy and geoarchaeology in the American Southwest: Geoarchaeology—An International Journal, v. 15, no. 6, p. 537–557.

Huckleberry, G., 1994, Contrasting channel response to floods on the middle Gila River, Arizona: Geology, v. 22, p. 1083–1086.